

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) An apparatus for asynchronous file-based replication of a hierarchically-indexed data store, the apparatus comprising:

a computing device for data replication, the computing device comprising:

a hierarchically indexed data store;

a file system driver configured to access the data store and track file regions that have changed since a first point in time image replication instance; and

a replication module configured to communicate data contained within changed file regions in response to a second point in time image replication instance.

a hierarchically indexed data store configured to store data in a hierarchical structure corresponding to a file system;

an operating system configured to access the hierarchically indexed data store and initiate write operations to the hierarchically indexed data store;

a first in-memory block map for tracking changes to the hierarchically indexed data store, the first in-memory block map comprising a plurality of status indicators configured to indicate changes to blocks on the hierarchically indexed data store;

a second in-memory block map for tracking changes to the hierarchically indexed data store, the second in-memory block map comprising a plurality of status indicators configured to indicate changes to blocks on the hierarchically indexed data store;

a tracking module comprising a file system driver configured to monitor write operations initiated by the operating system and track file regions that have changed since a first point-in-time replication instance by updating the status indicators in the second in-memory block map in a written order;

a replication module configured to asynchronously communicate data contained within file regions that have changed to a replication target as indicated by the first in-memory block map;

the file system driver further configured to access the first in-memory block map instead of the second in-memory block map in response to a second point-in-time replication instance;

the replication module further configured to access the second in-memory block map instead of the first in-memory block map in response to the second point-in-time replication instance and asynchronously communicate data contained within file regions that have changed to the replication target as indicated by the second in-memory block map, wherein the data is communicated in an order that is independent of the written order.

2. (Currently Amended) The apparatus of claim 1, further comprising a replication target configured to asynchronously receive the data contained within the changed file regions that have changed from the replication module source, write the data within corresponding files regions on the replication target, and initiate a point-in-time image replication operation configured to synchronize the replication target with the hierarchically indexed data store as structured at the second point-in-time replication instance replication source.
3. (Currently Amended) The apparatus of claim 1, wherein the replication module is further configured to clear the first in-memory block map subsequent to asynchronously communicating the data contained within the file regions indicated by the first in-memory block map communicate the data contained within the changed file regions in an order that is independent of a change order.
4. (Original) The apparatus of claim 1, wherein the replication module is further configured to conduct replication operations as directed by policies related to replication.

5. (Original) The apparatus of claim 1, further comprising a storage management module configured to set policies related to replication.
6. (Canceled)
7. (Original) The apparatus of claim 1, further comprising a point-in-time image replication module configured to provide point-in-time image replication services to the hierarchically-indexed data store.
8. (Original) The apparatus of claim 1, wherein the tracking module is further configured to save information regarding the file regions that have changed since the first point-in-time image replication instance.
9. (Canceled)
10. (Currently Amended) The apparatus of claim 8 1, wherein the file system driver is an installable driver.
11. (Currently Amended) The apparatus of claim 1, wherein the point-in-time image replication comprises a snapshot of the root node.

12. (Canceled)
13. (Canceled)
14. (Currently Amended) A method for asynchronous file-based replication of a hierarchically-indexed data store, the method comprising:
- ~~storing data on a hierarchically indexed data store;~~
- ~~using a file system driver to track file regions that have changed since a first point in-time image replication instance;~~
- ~~communicating data contained within changed file regions to a replication data store in response to a second point in time image replication instance.~~
- asynchronously communicating data contained within file regions that have changed to a replication target as indicated by a first in-memory block map;
- monitoring write operations to a hierarchically-indexed data store with a file system driver in order to track file regions that have changed since a first point-in-time replication instance wherein changes to the file regions occur in a written order;
- updating block status indicators in a second in-memory block map in response to the changes to the file regions;
- clearing the first in-memory block and updating block status indicators in the first in-memory block map instead of the second in-memory block map in response to a second point-in-time replication instance;
- asynchronously communicating data contained within file regions that have changed to the replication target as indicated by the second in-memory block map instead of the first in-memory block map in response to the second point-in-time replication instance, wherein asynchronously communicating data occurs in an order that is independent of the written order.

15. (Currently Amended) The method of claim 14, further comprising receiving data contained within the changed file regions that have changed from a replication source, writing the data within corresponding files regions on a replication target, and initiating a point-in-time image replication operation configured to synchronize the replication target with the replication source.

16. (Currently Amended) An apparatus for asynchronous file-based replication of a hierarchically-indexed data store, the apparatus comprising:

means for storing data on a hierarchically indexed data store;
a file system driver configured to track file regions that have changed since a first point-in time image replication instance; and
means for communicating data contained within changed file regions in response to a second point in time image replication instance.
means for asynchronously communicating data contained within file regions that have changed to a replication target as indicated by a first in-memory block map;
a file system driver configured to monitor write operations to a hierarchically-indexed data store and track file regions that have changed since a first point-in-time replication instance by updating block status indicators in a second in-memory block map;
means for clearing the first in-memory block;
the file system driver further configured to update block status indicators in the first in-memory block map instead of the second in-memory block map in response to a second point-in-time replication instance; and
means for asynchronously communicating data contained within file regions that have changed to the replication target as indicated by the second in-memory block map instead of the first in-memory block map in response to the second point-in-time

replication instance, wherein changes to the file regions occur in a written order and asynchronously communicating data occurs in an order that is independent of the written order.

17. (Currently Amended) The apparatus of claim 16, further comprising means for receiving data contained within the changed file regions that have changed from a replication source, means for writing the data within corresponding files regions on a replication target, and means for initiating a point-in-time image replication operation configured to synchronize the replication target with the replication source.

18. (Currently Amended) A system for asynchronous file-based replication of a hierarchically-indexed data store, the system comprising:

a replication target comprising a CPU and a first hierarchically-indexed data store configured to store data in a hierarchical structure corresponding to a file system;

a replication source comprising a CPU and a second hierarchically-indexed data store configured to store data in a hierarchical structure corresponding to a file system;
a file system driver configured to track file regions that have changed on the replication source since a first point in time image replication instance; and
a replication module configured to communicate data within changed file regions to the replication target in response to a second point in time image replication instance.

the replication source further comprising an operating system configured to access the second hierarchically indexed data store and initiate write operations to second the hierarchically indexed data store;

the replication source further comprising a first in-memory block map for tracking changes to the second hierarchically indexed data store, the first in-memory block map

comprising a plurality of status indicators configured to indicate changes to blocks on the second hierarchically indexed data store;

the replication source further comprising a second in-memory block map for tracking changes to the second hierarchically indexed data store, the second in-memory block map comprising a plurality of status indicators configured to indicate changes to blocks on the second hierarchically indexed data store;

the replication source further comprising a tracking module comprising a file system driver configured to monitor write operations initiated by the operating system and track file regions that have changed since a first point-in-time replication instance by updating the status indicators in the second in-memory block map in a written order;

the replication source further comprising a replication module configured to asynchronously communicate data contained within file regions that have changed to a replication target as indicated by the first in-memory block map;

the file system driver further configured to clear the first in-memory block and access the first in-memory block map instead of the second in-memory block map in response to a second point-in-time replication instance;

the replication module further configured to access the second in-memory block map instead of the first in-memory block map in response to the second point-in-time replication instance and asynchronously communicate data contained within file regions that have changed to the replication target as indicated by the second in-memory block map, wherein the data is communicated in an order that is independent of the written order.

19. (Original) The system of claim 18, wherein the replication target is further configured to receive the data within changed file regions from the replication source, write the data within

corresponding files regions on the replication target and initiate a point-in-time image replication operation configured to synchronize the replication target with the replication source.

20. (Currently Amended) The system of claim 18, wherein the replication module is further configured to clear the first in-memory block map subsequent to asynchronously communicating the data contained within the file regions indicated by the first in-memory block map communicate data contained within the changed file regions by communicating the data in an order that is independent of a write order.

21. (Currently Amended) A computer readable storage medium storing computer readable program code for conducting a method for asynchronous file-based replication of a hierarchically-indexed data store, the method comprising:

storing data on a hierarchically indexed data store;
using a file system driver to track file regions that have changed since a first point in time image replication instance;
communicating data contained within changed file regions in response to a second point in time image replication instance; and
synchronizing with a replication target via a standard point in time image replication operation;

asynchronously communicating data contained within file regions that have changed to a replication target as indicated by a first in-memory block map;
monitoring write operations to a hierarchically-indexed data store with a file system driver in order to track file regions that have changed since a first point-in-time replication instance wherein changes to the file regions occur in a written order;
updating block status indicators in a second in-memory block map in response to the changes to the file regions;

clearing the first in-memory block and updating block status indicators in the first in-memory block map instead of the second in-memory block map in response to a second point-in-time replication instance;

asynchronously communicating data contained within file regions that have changed to the replication target as indicated by the second in-memory block map instead of the first in-memory block map in response to the second point-in-time replication instance, wherein asynchronously communicating data occurs in an order that is independent of the written order.

22. (Currently Amended) The computer readable storage medium of claim 21, wherein the method further comprises receiving the data contained within the changed file regions that have changed from a replication source, writing the data within corresponding files regions on a replication target, and initiating a point-in-time image replication operation configured to synchronize the replication target with the replication source.

23. (Currently Amended) The computer readable storage medium of claim 21, wherein the method further comprises clearing the first in-memory block map subsequent to asynchronously communicating the data contained within the file regions indicated by the first in-memory block map communicating data contained within the changed file regions comprises communicating the data in a order that is independent of a write order.

24. (Original) The computer readable storage medium of claim 21, wherein the method further comprises communicating is conducted as directed by policies related to replication.

25. (Original) The computer readable storage medium of claim 21, wherein the method further comprises invoking point-in-time image replication services.
26. (Original) The computer readable storage medium of claim 21, wherein the method further comprises saving information regarding the file regions that have changed since the first point-in-time image replication instance.
27. (Original) The computer readable storage medium of claim 21, wherein the method further comprises tracking file regions is conducted in response to write operations.
28. (Original) The computer readable storage medium of claim 21, wherein the method further comprises saving information regarding the storage regions that have changed since the first point-in-time image replication instance.
29. (Original) The computer readable storage medium of claim 21, wherein the point-in-time image comprises a snapshot.
30. (Currently Amended) A file system driver for use in conducting point-in-time replication operations, comprising:
- a change tracking data structure comprising:
- a block index configured to logically identify blocks associated with a selected volume;
- a block address configured to indicate a physical location of a block within a storage device;
- a status indicator configured to indicate whether a change has been made to a block since a previously conducted point in time replication operation; and

a file index configured to identify a file associated with a selected data block;
a file system driver configured to monitor write operations initiated by an operating system and track file regions that have changed since a first point-in-time replication instance by updating the status indicators in a second in-memory block map in a written order;

the file system driver further configured to access the first in-memory block map instead of the second in-memory block map in response to a second point-in-time replication instance;